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STATE DOCUMENTS

MONTANA STATE DEPARTMENT OF HEALTH
Division of Environmental Sanitation

RECOMMENDED SPECIFICATIONS FOR DRILLING WATER WELLS FOR PUBLIC WATER SUPPLIES

Section I. General

A. Specifications are herewith prescribed to establish uniform minimum standards and methods of procuring and protecting an adequate supply of ground water, safe and fit for human consumption and for the processing and preparation of food products through proper location of wells, adequate construction or reconditioning of wells, development of wells, installation of pumping equipment and other methods approved by the State Department of Health in conformity with the laws of the State of Montana. The provisions of these specifications governing well construction apply to all wells intended or used for supplying water for human consumption, including those used in processing and preparation of foods.

B. Plans and specifications for all water wells drilled for public water supplies shall be submitted to the State Department of Health for their review and approval. Approval by the State Department of Health in writing shall be obtained before the construction contract is awarded or construction is begun. The plans shall include a plat showing the following:

1. Exact proposed well location.
2. The location and depth of existing wells, cesspools and septic tanks in a radius of 300 feet of the proposed well.
3. Information concerning the maximum high water elevation of any streams or other bodies of water adjacent to the well site.
4. The difference of elevation between the well and any bodies of water adjacent thereto.

C. Every person, firm or corporation intending to drill or causing to be drilled any water well for public water supply shall be duly registered as is required by law. This registration number shall be included in all contracts entered into for the purpose of drilling public water supply wells.

Section II. Definitions

For the purpose of these requirements, the following terms shall have the meaning prescribed to them in this section:

Adequate Water Supply means that the yield of a well or the capacity of a pump and piping system shall be sufficient to meet the requirements which the user has stated are necessary for the purposes for which well water is intended to be used.

Annular Space means the space between two circular objects, one of which surrounds the other, such as the opening between a drillhole and a casing pipe or between a casing pipe and a liner pipe.

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Approved means sanctioned in writing by the State Department of Health in conformity with applicable laws, regulations and specifications.

Cement Grout means a mixture consisting of one bag of cement (94 pounds) to five to six gallons of clean water.

Concrete Grout means a mixture consisting of cement, sand, and water in the proportion of one bag of cement (94 pounds) and an equal volume of dry sand to five to six gallons of clean water.

Consolidated Formations means consolidated rocks such as limestone, sandstone, or granite.

Drawdown means the lowering of the water surface in a well and of the water table or piezometric surface adjacent to the well, resulting from the withdrawal of water from the well by pumping.

Drillhole:

(a) Lower Drillhole means that part of the drillhole below the vertical zone of contamination.

(b) Upper Drillhole means that part of a drillhole, augerhole or excavation established through the vertical zone of contamination.

Driven Well means a well constructed by joining a "drive point" with a length of pipe, extended as may be necessary, and driving the assembly into the ground without a preliminary excavation in excess of 10 feet depth. So called "tubular" type wells are considered drilled type wells.

Flushing means the act of causing a rapid flow of water from a well by pumping, bailing or similar operation.

Natural Ground means the permanent elevation of the surface of the ground at the site of the well.

Near-surface Water means water in the zone immediately below the ground surface. It may include seepage from barnyards, leaching pools and disposal beds or leakage from sewers, drains and similar sources of contaminated water.

Processing and Preparation of Food means washing, cooking, cooling, pasteurizing, bottling, canning, or other processing or preparation of food, including the washing of utensils and equipment used in processing or preparation of food.

Pollution means such contamination or other alteration of the physical, chemical or biological properties of water as to render such water harmful or deterimental or injurious to public health, safety or welfare, or to legitimate beneficial use.

Public Water Supply means one from which water may be distributed, sold or made available to the people at large or to any considerable number of members of the public indiscriminately.

Pumping Water Level means that elevation of the surface of the water in a well when water flows or is pumped from it at the customary rate.

Safe Water means water that is free from contaminating matter.

Static Water Level means that elevation of the surface of the water in a well when no water flows or is being pumped therefrom.

Unconsolidated formation means unconsolidated rocks such as clay, sand, and gravel.

Well Seal means an approved removable arrangement or device used to cap a well or to establish and maintain a junction between the casing or curbing of a well and the piping or equipment installed therein, so as to prevent water from entering the well at the upper terminal.

Well Vent or Breather Pipe means an outlet at the upper end of the well casing to allow equalization of air pressure in the well.

Yield means the quantity of water per unit of time, which may flow or be pumped from a well.

Section III. Location and Depth

A. Location

1. Every well shall be located at the highest point practicable in the premises and as far removed from any known or probable sources of pollution as the general layout of the premises and the surroundings permit.

2. The well site shall be so drained that no surface water shall impound or accumulate within fifty feet horizontally from the well. In flood areas, the location shall be such that the flood waters will not approach closer than fifty feet horizontally from the well.

3. Minimum distances between the well and sources of pollution shall be maintained as follows:

    a. Seepage pits, filter beds or absorption fields, privies, cesspool or similar sewage disposal unit, 100 feet.

    b. Watertight grease trap, watertight septic tank or watertight tile sewer, 50 feet.

    c. Concrete encased cast iron sewer, 2 feet.

    d. Cast iron sewer having leaded joints, 2 feet.

    e. Sewer connected foundation drain, 100 feet.

    f. Independent clear water drain downspout, cistern or similar unit, 100 feet.

4. With respect to buildings, the location of the well shall be as follows:

    a. When a well is located adjacent to a building, it shall be located so that the center line of the well extended vertically will clear any projection from the building by not less than two feet.

b. Every well shall be located so that it will be reasonably accessible to proper equipment for cleaning, treatment, repair, test, inspection and other such attention as may be necessary.

c. Well heads, well casings, pumping machinery, exposed suction pipes or valve boxes connected with a suction shall not be located in any pit, room or space extended below this established natural ground surface.

B. Depth.

1. Wells shall be constructed to a depth which is sufficient to insure the satisfactory sanitary quality of the water. In no instance shall water be taken from depths of less than 20 feet below the natural ground surface.

2. The depth of wells in some geological formations, such as coarse gravel channeled, creviced or shattered rock formations and in particular instances where known contamination exists, may require greater depths than 20 feet below the natural ground surface. In such instances, the State Department of Health may require the construction of a well with special protective devices or with the provision that such water supplies shall receive adequate continuous treatment.

Section IV. Construction of Wells in Unconsolidated Formations

A. Caving Formations. All drilled or driven wells, constructed in geological formations of sand, gravel, or other such formations of a caving nature, extending the full depth of the well, shall have a permanent casing installed to a point 15 feet below the pumping level. The annular opening made during construction outside the upper part of the casing shall be filled with puddled clay, cement or concrete grout, or other material of equivalent quality.

B. Caving Formations with Stable Overlay. All wells constructed in geological formations of a caving nature which lie below clay, hardpan, shale or other stable unconsolidated material, shall be of grouted type construction or equal, extending through the stable unconsolidated formation. Where such wells are of double casing construction, the diameter of the outer casing shall be at least three inches greater than the inner casing. The annular space between the inner casing and outer casing shall be filled with puddled clay, cement or concrete grout, or other material of equivalent quality. The outer casing may be permanently placed or withdrawn as grouting or equivalent construction proceeds. Where permanently placed, the outer casing shall be withdrawn so as to place the lower end of such casing at least five feet above the bottom of the lowest stable unconsolidated formation. The protective (inner) casing shall extend ten feet below the pumping level.

C. Gravel Wall Construction. Wells of gravel wall construction may be used in unconsolidated formations. Such wells shall be of double casing construction and the diameter of the outer casing shall be at least 12 inches greater than the inner casing; provided, that where the hydraulic rotary method of drilling is used in unconsolidated non-caving formations, no outer casing may be required. The gravel surface shall terminate not less than 10 feet below the ground surface; and the annular space between the excavation line and the outside of the well casing, above the gravel surface, shall be filled with thoroughly compacted puddled clay, cement or concrete grout, or other material having at least equivalent protective qualities. All gravel shall be disinfected with a chlorine solution immediately before application to the well. If gravel refill pipes are used, they shall have a maximum diameter of three inches, and shall terminate in capped outlets raised above the natural ground or pumphouse floor a minimum of 12 inches.

D. Special Types. Dug wells and radial water collectors may be constructed in unconsolidated geological formations.

1. Dug Wells. If dug wells are constructed, retaining walls shall be watertight. If of concrete material, shall, if possible, be poured in one operation. If concrete or clay pipe is used, the upper 10 feet shall be encased in a concrete shell of at least 1 1/2 inches thickness. The cover shall be made of substantial reinforced watertight concrete of sufficient diameter to overlap the wall by at least 2 inches. The cover shall be free from joints. A manhole, if installed, shall be provided with a curb, the top of which extends 6 inches above the slab, and equipped with a locked or bolted overlapping cover, the sides of which extend downward at least 4 inches.

2. Radial Water Collectors. If radial water collectors are constructed, they shall at least equal construction requirements established in Section D-1 above for dug wells. Caisson walls of radial water collectors shall be adequately reinforced. Projection of collectors shall be in a horizontal plane.

Section V. Construction of Wells in Consolidated Formations.

A. Casing and Grouting. The casing of all wells constructed in consolidated geological formations shall be surrounded by puddled clay, cement or concrete grout, or material of equivalent quality to a depth of at least 10 feet, or such depth as necessary to exclude pollution.

B. Creviced Formations. Formations which are channeled, creviced, fractured, or shattered shall not be used as a source of ground water supply, unless overlain by a mantle of unconsolidated formations to a depth of at least 50 feet for a radius of one-half mile from the site of the well; provided, however, that where no other source of water supply is available, the authorized representative of the State Department of Health may authorize the construction of a well which derives its water supply from channeled, creviced, fractured, or shattered rock. Such water supplies shall receive adequate continuous treatment and the sanitary quality of the water shall be checked regularly by the authorized representative of the State Department of Health.

C. Unconsolidated Mantle Overlying Creviced Formations. All wells, constructed in channeled, creviced, shattered or fractured rock formations, overlain with a mantle of unconsolidated formations to a depth of at least fifty feet within a radius of one-half mile from the site of the well, shall have a protective casing, surrounded by puddled clay, cement or concrete grout, or material of equivalent qualities approved by the State Department of Health, extending at least 10 feet below the pumping level.

D. Water-Bearing Rock Below Creviced Formations. Where an adequate and safe water supply is available in a rock formation overlain by a creviced rock formation, the creviced rock formation shall be completely cased off and watertight construction shall be extended at least 10 feet into the safe water-bearing rock formation.

E. Impervious Formation Underlying Creviced Formations. Where a formation known to be impervious and continuous underlies a creviced formation and overlies an adequate and safe water-bearing formation, termination of the protective casing in the top of the impervious formation shall be permitted. If the impervious formation is of a caving nature, a liner shall be installed through such impervious formation to the safe water-bearing formation. The liner shall not be less in diameter than the protective casing and the lower terminal of such liner shall be adequately sealed or set in puddled clay, cement or concrete grout, or material of equivalent qualities.

Section VI. Other Type Wells

A. Artesian Wells. All artesian wells shall be constructed in accordance with the provisions governing drilled wells in similar geological formations. In the construction of artesian wells, initial drilling operations shall extend into, but not through, the impervious formation confining the water under artesian head. The protective casing and annular space seal of puddled clay, cement or concrete grout, or material of equivalent qualities shall then be installed and allowed to set. After the annular space seal has set, drilling operations shall then be continued into the artesian strata.

Section VII. Construction Materials and Practices.

A. Drillhole. The diameter of the drill hole from the ground surface to the casing point shall be at least 3 inches greater than the nominal diameter of the casing to assure proper sealing of the casing as provided below.

B. Casing.

1. The casing shall be centered in the drillhole. Spacer guides to center the casing shall be provided at the top and at the bottom of the casing and along the entire length of the casing, spaced not to exceed more than 100 feet apart. The spacer guides shall be installed parallel to the casing and shall in no way interfere with the cement grouting of the well.

2. The protective casing shall be constructed of wrought iron or steel having minimum characteristics as specificed by Tables 1 and 2 or other materials having equivalent protective qualities. Well casing pipe other than wrought iron or steel shall be adaptable to the strain to which the pipe shall be subjected during the installation and the corrosiveness of the water or soil.

3. Drive Shoe. Pipe that is to be driven shall be equipped with a drive shoe.

4. Joints. Casing and liner pipe joints shall be welded or threaded.

5. Outer Casing and Liners. Outer casing and liners, installed without driving, may be of lighter weight than specified by Tables 1 and 2. Such lightweight pipe shall have a minimum thickness of 0.25 inch. A three-inch annular opening shall be provided, between such lightweight outer casing and the protective casing, for filling with puddled clay, cement or concrete grout, or other material having at least equivalent protective qualities.

C. Screens. Screen openings shall provide the maximum amount of open area, consistent with strength and the grading of the water-bearing formation; shall permit maximum transmitting ability without clogging or jamming; and shall be constructed of material which is not subject to attack by the chemical action of the ground water. The screen length and placement shall be in such setting as to prevent exposure above the pumping water level. The screen shall be designed to permit removal or replacement without adversely affecting the watertight construction of the well.

D. Grouting. All grouting shall be performed by adding the mixture from the bottom of the space to be grouted towards the surface in one continuous operation. Sufficient annular opening shall be provided to permit a minimum of 1 1/2 inches of grout around the casing.

E. Capping. A properly fitted and firmly driven, solid, wooden plug shall be the minimum acceptable method of capping a well until pumping equipment is installed.

F. Yield. Before being put into use, every well shall be tested for yield and drawdown. The test pump shall have a maximum capacity of at least equal to, and a minimum capacity 20 percent of, the quantity of water it is anticipated the well will produce. The test pump shall be installed to operate continuously until the water level has stabilized and, at this point, the yield and drawdown determined. Periodic observations shall be made of drawdown and returning water levels.

G. Plumbness and Alignment. Before being put into use, every well shall be tested for plumbness and alignment. A 40-foot dummy, having an outer diameter one-half inch smaller than the diameter of the casing or hole being tested, shall move freely throughout the length of casing or hole to the lowest anticipated pump setting. The well shall not vary from the vertical in excess of two-thirds the smallest inside diameter of that part of the well being tested per 100 feet of depth.

H. Upper Terminal of Well. The casing pipe of any drilled or driven well shall project not less than 12 inches above the pumphouse floor or cover installed above the established ground surface. The protective casing shall allow for a one-inch extension into the pump base. Any vent opening, observation ports and air line equipment shall extend from the upper terminal of the well by watertight piping to a point not less than 12 inches above the upper terminal. The terminals of these facilities shall be shielded or sealed so as to prevent entrance of foreign matter.

Section VIII. Development.

A. General. Well drillers shall furnish all necessary pumps, compressors, plungers or other needed equipment, and shall develop the well by approved methods as shall be necessary to give the maximum yield of water per foot of drawdown and extract from the well the maximum practical quantity of such sands as may, during the life of the well, be drawn through the screen when the well is pumped under maximum conditions of drawdown.

B. Blasting and Chemical Conditioning. Specifications covering method, equipment and controls for the blasting or chemical conditioning to increase the yield of ground water structures shall be submitted for approval to the State Department of Health.

Section IV. Pump Installations.

A. Pumphouse. (See sketches in this bulletin showing approved pump installations.)

1. No pump shall be installed in a well pit or subground level pump room. The floor shall be at least 6 inches above the ground surface, and in cases where the pumphouse is located on a steep hill, at least 50 percent of the floor area shall be at least 6 inches above the ground level.

2. The pump shall be installed on a concrete base of sufficient height to permit the outside casing to extend not less than 13 inches above the pump room floor. The casing shall extend one inch above the concrete base. If the cement grout seal has settled below ground level, the annular opening between the drillhole and casing shall be filled with cement grout before the pump base and pumphouse floor are constructed. If the well is of the gravel wall type, the outer casing shall extend at least 12 inches above the pump room floor with suitable provisions made for adding gravel. The inner casing shall extend one inch above the base.

3. The pump room floor shall be watertight and shall slope away from the pump base. The pump room floor shall be provided with a floor drain consisting of a sewer pipe not less than 8 inches in diameter, with cemented joints, installed in a straight line and on an even grade of not less than 0.5 foot per 100 feet, and with a concrete bulkhead at the outlet to insure an open discharge at all times. Under no conditions shall this drain receive sewage or any other drainage to be connected to a sewer. The drain shall terminate not less than 50 feet horizontally from the well. The pump room floor level shall be above high water level in any adjacent watercourse and elevated at least 6 inches above normal ground surface level. In any case, the top of the well casing shall terminate not less than 2 feet above known flood elevation.

B. Annular Space Between Casing and Pump Column.

1. The annular space between the casing and pump column shall be closed or sealed by means of a suitable watertight connection which will effectively prevent waste water, oil, insects or other contaminating material from entering the well. If the well is of the gravel wall type, the annular space between the outside casing and the inside casing shall be closed with a watertight connection and likewise for the annular space between the inside casing and the pump column.

2. There shall be no holes in the pump base which might allow waste water or other material to enter the well. A breather tube may be installed. If a breather tube is used it shall be of sufficient size to permit air to enter and leave the well freely with the changing of water elevation caused by starting and stopping the pump. The breather tube shall terminate in a full 180° bend at least two feet above the floor, securely screened with 16 mesh wire screen. If the breather tube or a depth gauge line passes through the base of the pump or through the seal connection into the well, the hole about the tube shall be sealed with a threaded joint, with a welded joint, or by using jute and lead or other effective devices approved by the State Department of Health.

C. Pump Column or Drop Pipe.

1. A separate pump column, suction or discharge pipe shall be installed inside the well casing in all instances, whether the well is to be pumped by suction, airlift, or deep well pump.

D. Depth or Drawdown Gauge.

1. A depth or drawdown gauge for determining location of the water level shall be installed during the installation of the pump.

E. Water Meter.

1. It is recommended that a water meter be installed on the pump discharge line.

F. Provision for Water Sampling.

1. A faucet shall be provided on the discharge line on the upstream side of the check valve as near the pump as possible, for the purpose of drawing samples for water analyses.

Section X. Disinfection, Sampling and Reports.

A. Disinfection. Every new, modified or reconditioned water source, including pumping equipment, shall be disinfected before being placed in service for general use. After all construction on wells or other ground water developments, including pumping equipment, has been completed, it shall be thoroughly cleaned of all foreign substances, including tools, timbers, rope, debris of any kind, cement, oil, grease, joint dope and scum. The casing pipe shall be thoroughly swabbed, using alkalies if necessary to remove oil, grease or joint dope. The well or other ground water development, including the pumping equipment, shall then be disinfected with a chlorine solution which shall be of such volume and strength, and so applied, that a concentration of at least 50 parts per million of chlorine shall be obtained in all parts of the well for a period of at least 10 hours.

B. Water Samples. One or more water samples from well installations shall be submitted to the State Department of Health laboratory for chemical and sanitary analysis and shall be found satisfactory by such laboratory before such installations shall be placed in service.

C. Sanitary Surveys. Approval of well installations shall be based on a sanitary survey by the authorized representative of the State Department of Health.

D. Continuous Disinfection. Where the authorized representative of the State Department of Health finds that the ground water source is subject to con-contihuous or intermittent pollution, provisions for continuous disinfection, in accordance with the recommendations of the authorized representative of the State Department of Health, shall be provided.

E. Well Record. Drill cuttings shall be obtained at 5-foot intervals and at all pronounced changes in formations, and shall be submitted to the proper state authorities. The engineer, owner or driller shall supply the proper state authority with an accompanying accurate record of the drillhole diameters, assembled order of size and length of casings and liners, grouting depth, water levels, location of blast shots and pumping test.

Section XI. Abandonment of Wells

A. Until a well is permanently abandoned, all provisions for the protection of the water against contamination and for maintaining the safe sanitary conditions around the well shall be carried out.

B. When a well is permanently abandoned, it shall be disconnected from the system and the hole filled to restore natural conditions as far as possible. Neat cement grout, concrete, puddled clay are satisfactory for filling wells in rock formations. Natural earth, sand, and graveled clay may be used for filling wells in unconsolidated materials.

C. In no instance shall an abandoned well be used as a cesspool, nor shall any sewage, household drainage or other contaminating material be discharged into said abandoned well.

TABLE 1

Steel Pipe, Black or Galvanized*

Nominal Size (Inches)	Diameter (inches)		Thickness (inches)	Weight per foot (pounds)**	
	External	Internal		Plain Ends Calculated	Threads and Couplings Nominal***
6 id.	6.625	6.065	0.280	18.97	19.45
8	8.625	7.981	0.322	28.55	29.35
10	10.750	10.020	0.365	40.48	41.85
12	12.750	12.000	0.375	49.56	51.15
14 od.	14.000	13.250	0.375	54.57	57.00
15	15.000	14.250	0.375	58.57	61.15
16	16.000	15.250	0.375	62.58	65.30
17	17.000	16.214	0.393	69.70	73.20
18	18.000	17.182	0.409	76.84	81.20
20	20.000	19.182	0.409	85.58	90.00
21	21.000	20.125	0.438	96.07	
22	22.000	21.125	0.438	100.75	
24	24.000	23.125	0.438	110.10	
26	26.000	25.125	0.438	119.44	
28	28.000	27.000	0.500	146.85	
30	30.000	29.000	0.500	157.53	
32	32.000	30.875	0.563	188.86	
34	34.000	32.875	0.563	200.87	
36	36.000	34.750	0.625	236.13	

* 6-20-inch dimensions and weights from API Specifications 5-L for Line Pipe: 22-28 inch dimensions and weights from AWWA Specifications 7A.4: 30-inch dimensions and weights from U.L. Specifications I-888: 21, 32, 34 and 36-inch dimensions and weights not derived from standards.

** Permissible variation in weight is 10 percent above and 3.5 percent below, but the carload weight shall not be more than 1.75 percent below nominal weight.

*** Based on a length of 20 feet, including coupling. Threaded pipe has 8 threads per inch.

NOTE: Welded joints advocated for pipe larger than 20 inches in diameter; also for smaller diameter pipe, where applicable, to obtain clearance and maintain uniform grout thickness.

TABLE 2

Wrought Iron Pipe, Black or Galvanized*

Nominal Size (inches)	Diameter (inches)		Thickness (inches)	Weight per foot (pounds)**	
	External	Internal		Plain Ends Calculated	Threads and Couplings Nominal***
6 id.	6.625	6.053	0.286	18.97	19.45
8	8.625	7.967	0.329	28.55	29.35
10	10.750	10.005	0.372	40.48	41.85
12	12.750	11.985	0.382	49.56	51.15
14 od.	14.000	13.234	0.383	54.56	57.00
15	15.000	14.234	0.383	58.57	61.15
16	16.000	15.234	0.383	62.57	65.30
17	17.000	16.197	0.401	69.70	73.20
18	18.000	17.165	0.417	76.84	81.20
20	20.000	19.165	0.417	85.57	90.00
22	22.000	21.125	0.438	98.77	
24	24.000	23.125	0.438	107.96	
26	26.000	25.125	0.438	117.12	
28	28.000	27.000	0.500	143.99	
30	30.000	29.000	0.500	154.46	

* 6-12-inch dimensions from ASTM Specifications A72-39, weights from manufacturer's specifications for wrought iron line pipe: 14-20-inch dimensions and weights from manufacturer's specifications for wrought iron pipe: 22-30 inch dimensions and weights from manufacturer's specifications for wrought iron large od. pipe.

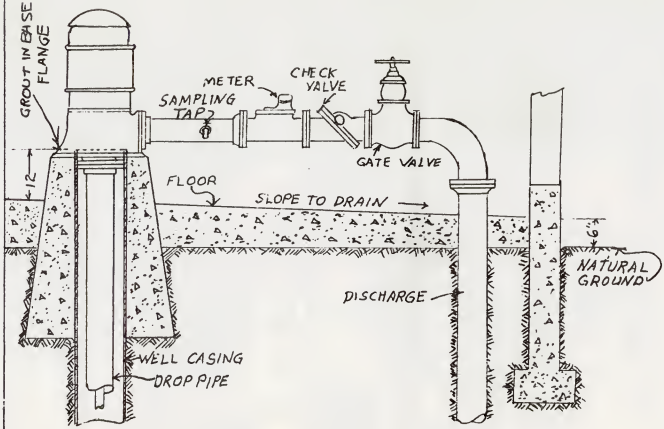
** Manufacturer's tolerance above or below nominal weight is 5 percent for 6 to 20-inch pipe and 10 percent for larger sizes.

*** Based on a length of 20 feet, including coupling. Threaded pipe has 8 threads per inch.

NOTE: Welded joints advocated for pipe larger than 20 inches in diameter; also for smaller diameter pipe, where applicable, to obtain clearance and maintain uniform grout thickness.

NOTE: PUMPHOUSE DOOR SHALL OPEN OUT

FLOOR DRAIN SHALL DISCHARGE TO ATMOSPHERE



BASE DESIGN
FOR DEEP WELL TURBINE PUMPS